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TECHNICAL REPORT ARCCB-TR-94013

QUALIFICATION OF M256 BREECHBLOCK REPAIR PROCEDURE

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MARCH 1994

US ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
March 1994

3. REPORT TYPE AND DATES COVERED
Final

4. TITLE AND SUBTITLE
QUALIFICATION OF M256 BREECHBLOCK WELD REPAIR

5. FUNDING NUMBERS
AMCMS No. 6126.24.H180.0
PRON No. 1A12ZTP9NMSC

6. AUTHOR(S)
David A. Porter, William E. Marcoux, and Alice E. Fish

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army ARDEC
Benet Laboratories, SMCAR-CCB-TL
Watervliet, NY 12189-4050

8. PERFORMING ORGANIZATION REPORT NUMBER
ARCCB-TR-94013

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army ARDEC
Close Combat Armaments Center
Picatinny Arsenal, NJ 07806-5000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

A more engineered approach was taken to qualify an M256 breechblock weld repair procedure. The approach consisted of (1) identifying the principal areas requiring weld repair, (2) identifying a weld procedure and material, (3) preparing weld repair specimens, and (4) accumulating a shock and vibration history similar to that expected in service.

14. SUBJECT TERMS
M256, Breechblock, Welding, Repair

15. NUMBER OF PAGES
20

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

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ACKNOWLEDGEMENTS

The authors would like to extend their thanks to Earl Morrissey for his assistance in coordinating the weld repair of candidate breechblocks and Larry McNabb of Alliant Techsystems at Socorro, New Mexico, who provided test support during this, and other, concept proveouts. Thanks also to Priscilla Varin, Gail Burnell, and Elaine DeBruyn of Configuration Branch, Engineering Division, for their help in preparing the figures, which make up a part of this technical report and their devoted assistance in the preparation of other graphical presentations.

Without the help of these highly motivated and skilled individuals, the completion of worthy projects of this type would undoubtedly be more difficult if not impossible.

STATEMENT OF THE PROBLEM

When production began on the M256 cannon at Watervliet Arsenal, there occurred the simultaneous introduction of a new weapon system with its own specific geometries and the use of a recently installed Flexible Manufacturing System (FMS). The use of an FMS eliminated labor intensive setup, teardown, and material transport, thus permitting lower production costs and higher production rates. An unfortunate side effect of this system is the error that can sometimes occur when equipment setup is less than perfect: the generation of regularly-occurring machining defects that can appear on several components before the automated process is inspected. The need for a repair procedure for machining defects in the M256 breechblock developed from these events.

BACKGROUND

The M256 breech mechanism is a semi-automatic sliding wedge design, wherein the breechblock is designed to move upward within the breech recess and lock behind the rear face of the stub case of 120-mm ammunition cartridges following loading into the cannon tube chamber. Camming of the operating crank on counterrecoil or counterclockwise rotation of the separable breech opening handle rotates the operating shaft and causes the breechblock crank to lower the breechblock. When the breechblock nears the open-end position, the extractors cause ejection of the ammunition stub case simultaneously with the locking of the breechblock in the opened position until tripped by the loading of a round of ammunition. The location of the breechblock within the breech recess subjects it to compressive stresses from the cartridge case on one side and the restraining force of the breech ring on the opposite side. The breechblock contains the electrical contact firing mechanism and such circuitry as necessary to transmit the electrical signal to the probe, which comes in contact with the ammunition cartridge primer. The breechblock also causes retraction of the firing mechanism probe as the breechblock cycles from its closed (firing) position to the open position. To accomplish this, a driver is actuated by the breechblock crank, which actuates the cam in the firing mechanism assembly causing the probe to protrude through the faceplate of the breechblock and contact the rear face of the cartridge. The aforementioned components can be seen in Figure 1.

The breechblock is manufactured from an alloy steel forging (per MIL-S-46172, Grade B) heat treated to develop ultra-high strength (1030 MPa). The chemical composition and processing of the breechblock are identical to the M256 cannon tube, except for the tube's requirement of electroslag remelt (ESR) material. Listings of chemical and mechanical property requirements are contained in Tables 1 and 2. The heat treated forging is machined and subsequently nitrided using an ion nitride process. By comparison, the breechblock of the M68/M68A1 cannon is manufactured from steel conforming to MIL-S-5000 that is an aircraft quality E-4340 material with superficial hardening of some cam surfaces. Although the materials are dissimilar, a substantial amount of previous weld repair work on M68 breechblocks aided in the development of this repair procedure.

APPROACH TO THE PROBLEM

It is the mission of Benet Laboratories Product Engineering Branch to provide the user with a product that will perform in a predictable and reliable fashion with a minimum of maintenance. In support of this mission, Product Engineering Branch has worked closely with the Watervliet Arsenal (the U.S. Army's principal manufacturer of large caliber cannon) on repair procedures that will either make discrepant component parts usable or repair cosmetic defects to maintain a high degree of user confidence in their cannon.

Regularly-occurring machining-induced defects affect both functional and nonfunctional surfaces; the features accounting for the majority of defects are highlighted in Figures 2, 3, and 4. A test specimen of M256 breechblock material was provided to the Process Engineering Branch of Benet's Engineering Support Division for application of different weld filler metals. These weld filler metals were specially selected for their ultra-high strength in the as-cast condition; their properties are described in Tables 3 through 7. The specimen was then subjected to a metallurgical analysis to identify any potential difficulties with the process and select the best

filler metal for the application (ref 1). The 517 filler metal was not selected for use in this application because of its relatively high carbon content. This high carbon content can cause cracking if not properly heat treated prior to and after welding. A typical pre/post weld heat treatment cycle could produce distortion of a component that has already been machined to fine tolerances. The requirement, therefore, shifted to filler metal with a lower carbon content and without the need for a substantial heat treatment following weld application. ER120S-1 was chosen because of its similarity to the 140S-1 material previously tested, as well as its low cost (approximately $9 per pound versus $14 per pound for 140S-1) and availability. Specification of either filler metal would have provided a product that would meet mechanical property requirements since the base metal mechanical properties are the primary factor in welds of this nature.

A preliminary weld repair procedure was created (SARWV Weld Repair Procedure No. 35, Appendix A), which requires weld application and remachining prior to ion nitriding. The maximum depth of weld permitted is 4.76 mm (3/16 inch). Two M256 breechblocks were selected to simulate tool gouges and other defects that represent 90 percent of the nonconforming material conditions reported. As a result, breechblock shop numbers 1419 and 2814 were machined, welded, remachined, and subsequently ion nitrided. These breechblocks were subsequently shipped to the New Mexico Institute of Mining Technology, TERA Group, Socorro, New Mexico, where they were installed in cannon assemblies and fired. Figures 5 through 8 show the appearance of breechblock shop number 1419 after weld repair and after finish machining in the areas of concern.

Test requirements mandated a minimum of 1000 rounds on each breechblock to confirm the suitability of the weld repair. Although 1000 rounds is less than the 4500-round safe service life of the M256 breech mechanism, it was determined that if anything were wrong with the weld repair, it would become evident long before this limit was achieved. An M256 breechblock has been subjected to 22,000 cycles (live firing and laboratory fatigue cycles) without incident, and no M256 breechblock has ever failed in fatigue. This indicates a high safe service life for this component that would be uneconomical and technically frivolous to verify.

RESULTS

Shop number 1419 exceeded 1000 rounds by October 1990 and shop number 2814 followed three months later in December 1990. These dates were only seven to nine months after the breechblocks were shipped to Socorro. A previous attempt at weld repair qualification accumulated only 300 rounds in two years. These components were returned to Watervliet Arsenal for evaluation using magnetic particle inspection. Magnetic particle inspection was selected for evaluation of the breechblocks since it can be used to identify indications on the surface and in the immediate region beneath the surface. The breechblocks were magnetized and flooded with solution and examined under black light. Each of the weld areas was scrutinized for indications of any size or shape with none in evidence. When the weld repair breechblocks were evaluated against the magnetic particle inspection criteria contained in Drawing A7309992 (Appendix B), it was determined that they exceeded inspection requirements.

CONCLUSIONS

The breechblocks accumulated 1000 rounds and functioned properly during test firing at Socorro, New Mexico. On subsequent inspection, the weld repair breechblocks showed no defects resulting from application of weld filler metal to repair surface imperfections.

Weld Repair Procedure No. 35 is a viable means of recovering M256 breechblocks that would otherwise be unsuitable for production use. At the time of this writing, 90 M256 breechblocks have been weld repaired and utilized in production cannon at a savings of over $450,000.

REFERENCES

1. Alice E. Misailidis, "Ion-Nitrided TIG Welded Test Plates," Memo for Record, Benet Laboratories, Watervliet, NY, 19 December 1988.

Table 1. Chemical Composition of M256 Breechblock, P/N 12529521

(Weight Percent)

Element	Chemistry
Carbon	0.30/0.40
Silicon	0.15/0.35
Manganese	0.40/0.70
Phosphorus	0.015 max
Sulfur	0.015 max
Aluminum	0.015 max
Chromium	1.00/1.40
Molybdenum	0.35/0.60
Nickel	2.50/3.20
Vanadium	0.08/0.20

Table 2. Mechanical Properties of M256 Breechblock, P/N 12529521

Yield Strength	1030 MPa min
Tensile Strength	1260 MPa max
Reduction in Area (%)	45 min
Elongation (%)	13 min
-40°C Charpy Impact	31 joules

Table 3. Chemical Composition of Weld Filler Metal, AWS A5.28 Class ER120S-1

(Weight Percent)

Element	Chemistry
Carbon	0.07
Silicon	0.35
Sulfur	0.0008
Phosphorus	0.0006
Chromium	0.45
Nickel	2.40
Molybdenum	0.55
Manganese	1.55

Table 4. Mechanical Properties of HY-100 Steel

Yield Strength	760 MPa min
Tensile Strength	860 MPa min
Reduction in Area (%)	50 min
Elongation (%)	15 min
-46°C Charpy Impact	96 joules min

Table 5. Chemical Composition of Weld Filler Metal, MIL-E-24355 (140S-l)

(Weight Percent)

Element	Chemistry
Carbon	0.11
Silicon	0.35
Sulfur	0.0008
Phosphorus	0.0005
Chromium	0.70
Nickel	2.60
Molybdenum	0.90
Manganese	1.60

Table 6. Mechanical Properties of HY-130/150 Steel

Yield Strength	930 MPa min
Tensile Strength	1030 MPa max
Reduction in Area (%)	45 min
Elongation (%)	14 min
-1°C Charpy Impact	75 joules min

Table 7. Chemical Composition of Weld Filler Material, AWS A5.23 Class EB2H (Chromenar 517)

(Weight Percent)

Element	Chemistry
Carbon	0.30
Silicon	0.65
Sulfur	--
Phosphorus	--
Chromium	1.20
Vanadium	0.25
Molybdenum	0.50
Manganese	0.55

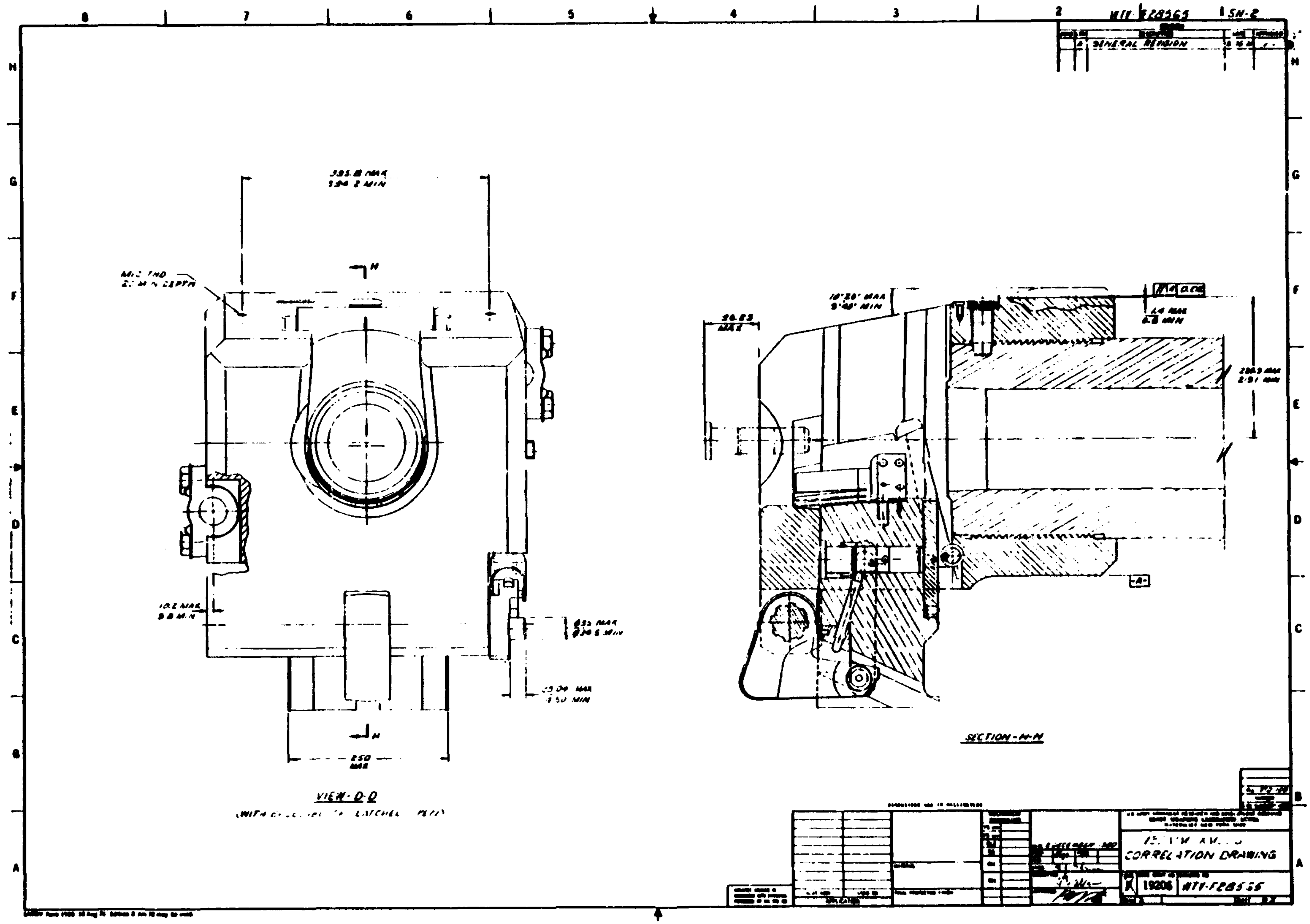


Figure 1. Drawing depicting the M256 breechblock as it is installed in the M256 breech ring assembly.

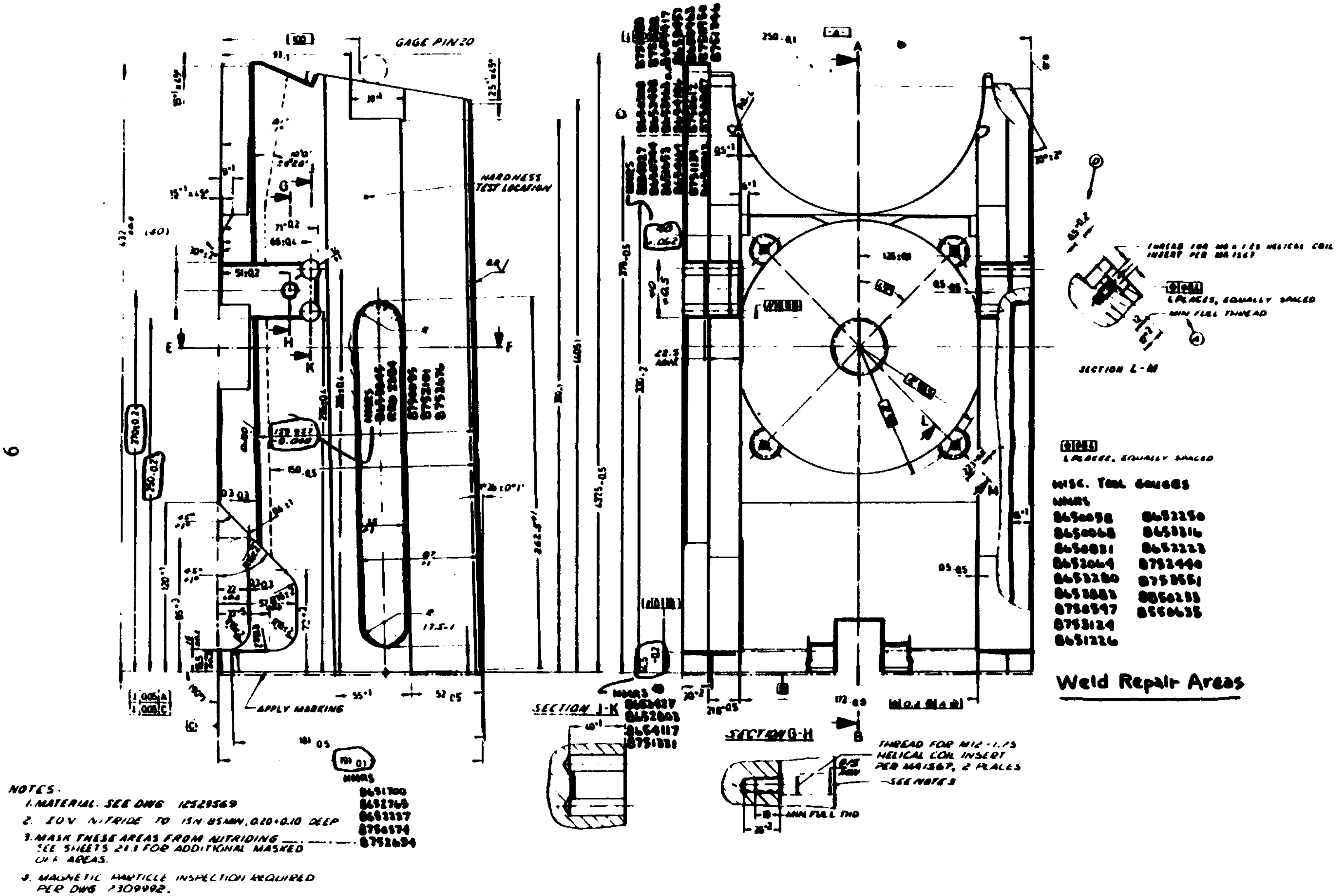


Figure 2. Location of nonconformances that resulted in weld repair development.

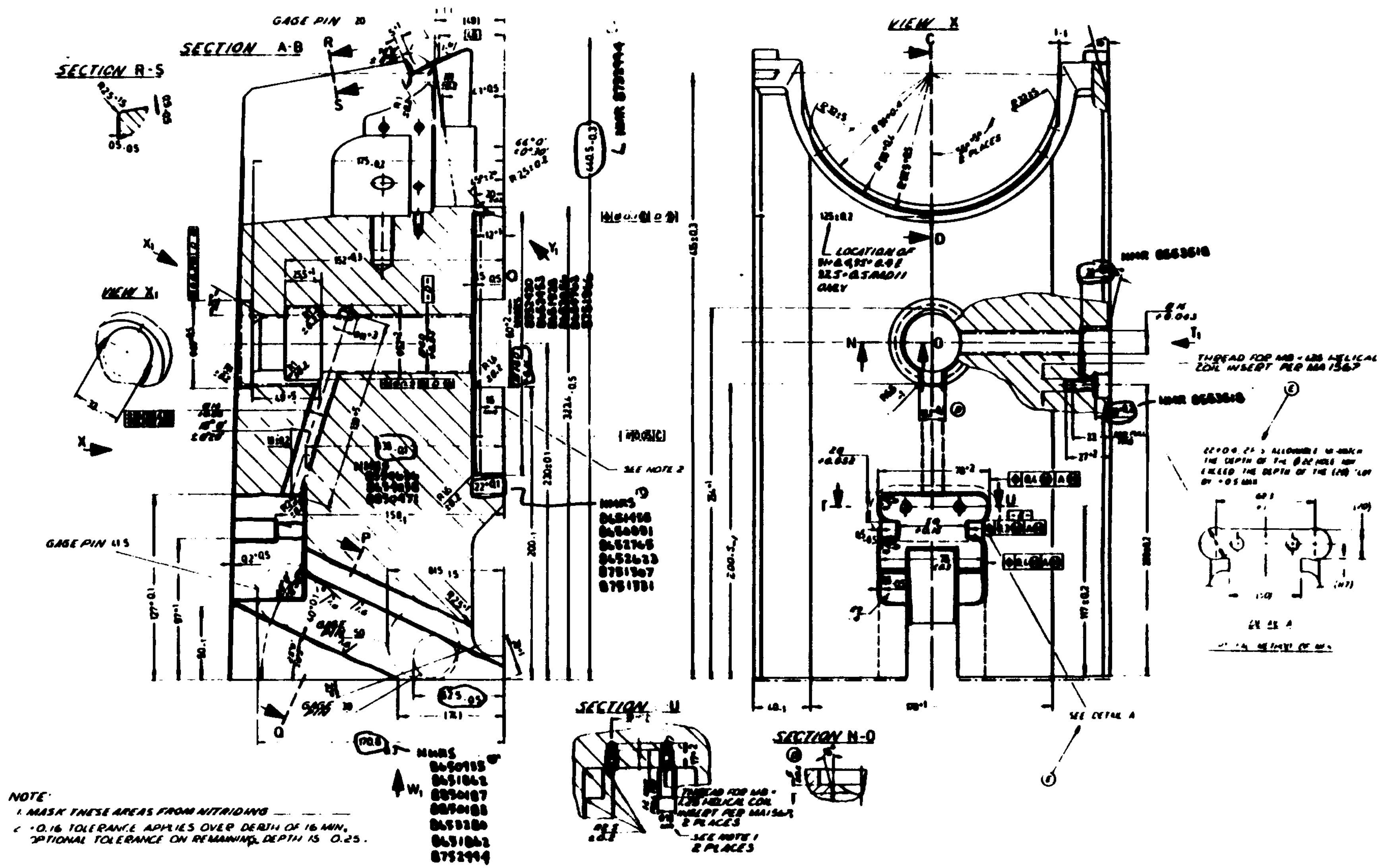


Figure 3. Location of nonconformances that resulted in weld repair development.

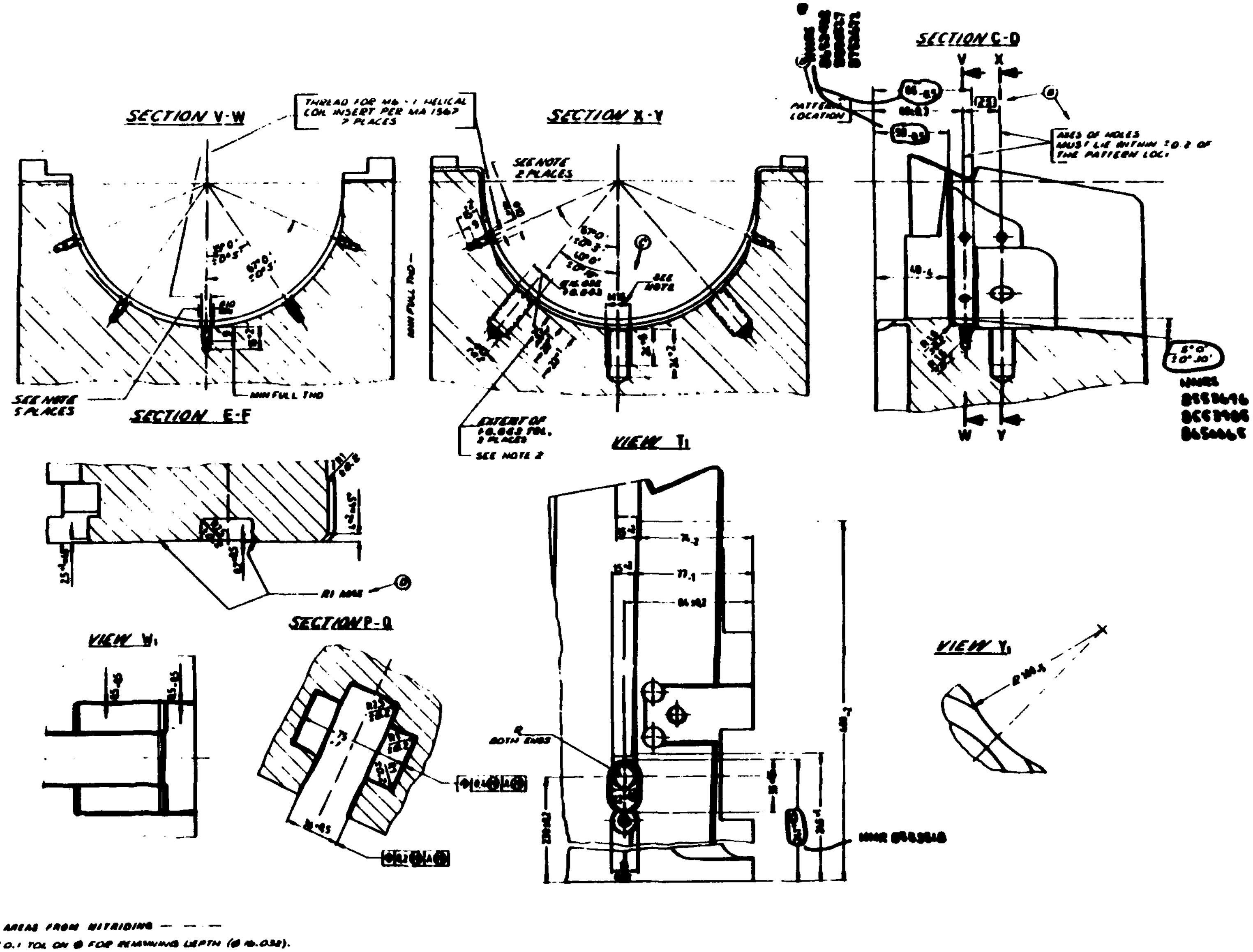
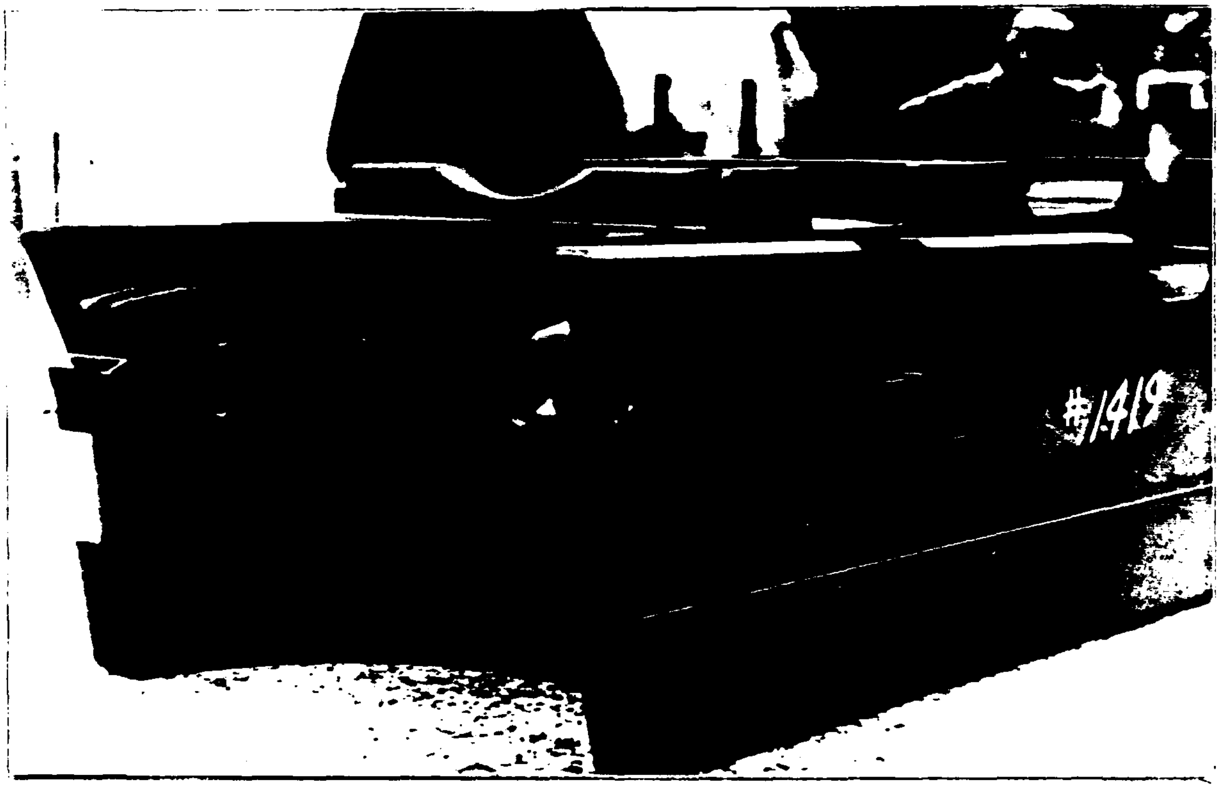


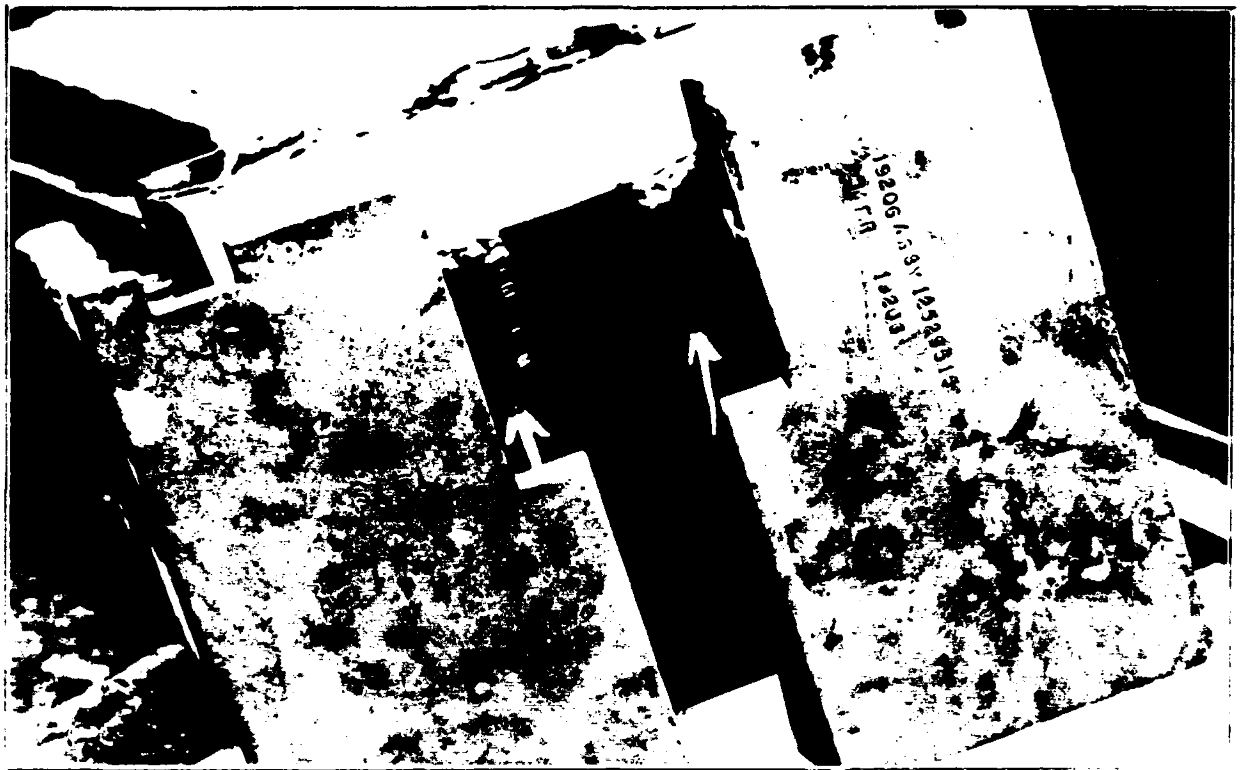
Figure 4. Location of nonconformances that resulted in weld repair ... ment.

(a)



(b)

Figure 5. Photographs showing weld repair breechblock specimens (a) prior to and (b) after finish machining.



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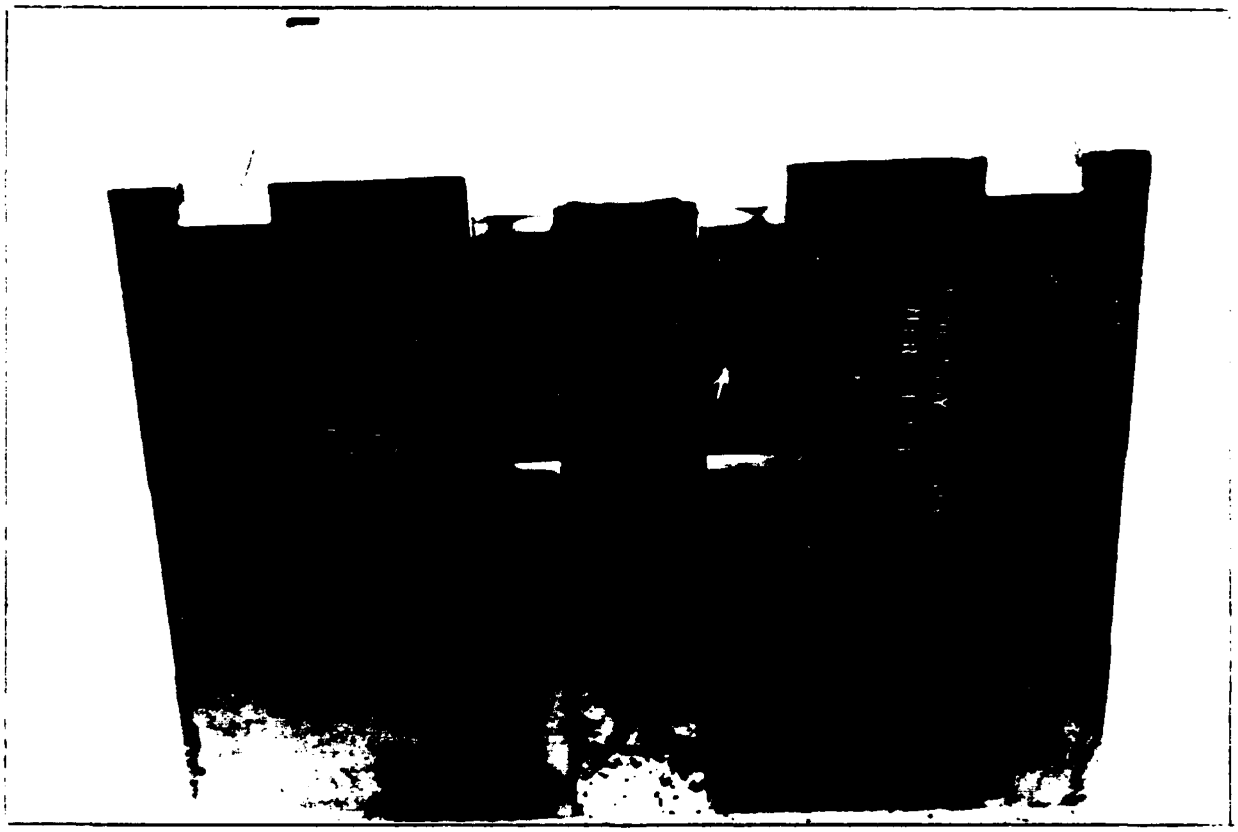
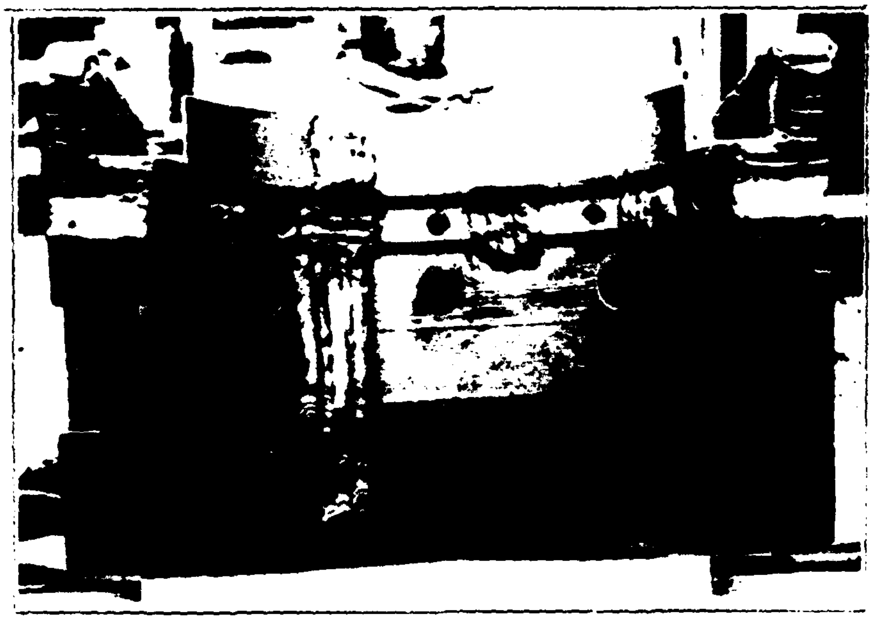


(b)

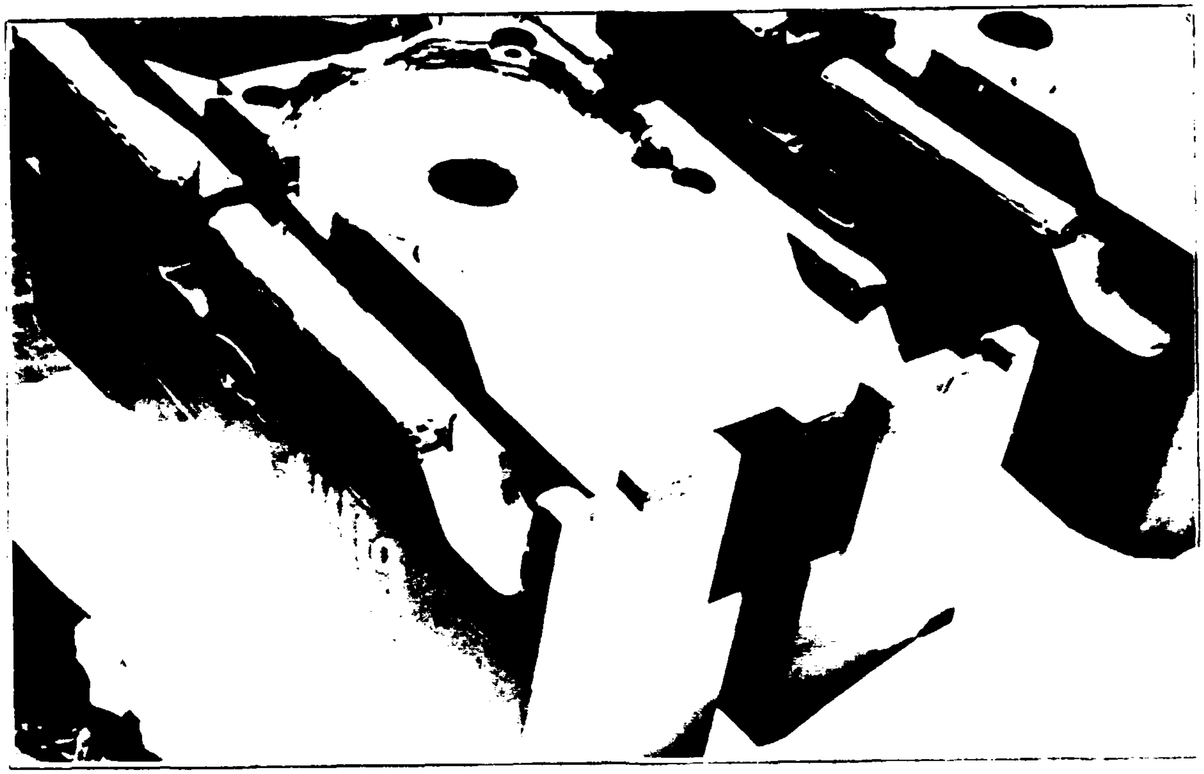
Figure 6. Photographs showing weld repair breechblock specimens (a) prior to and (b) after finish machining.



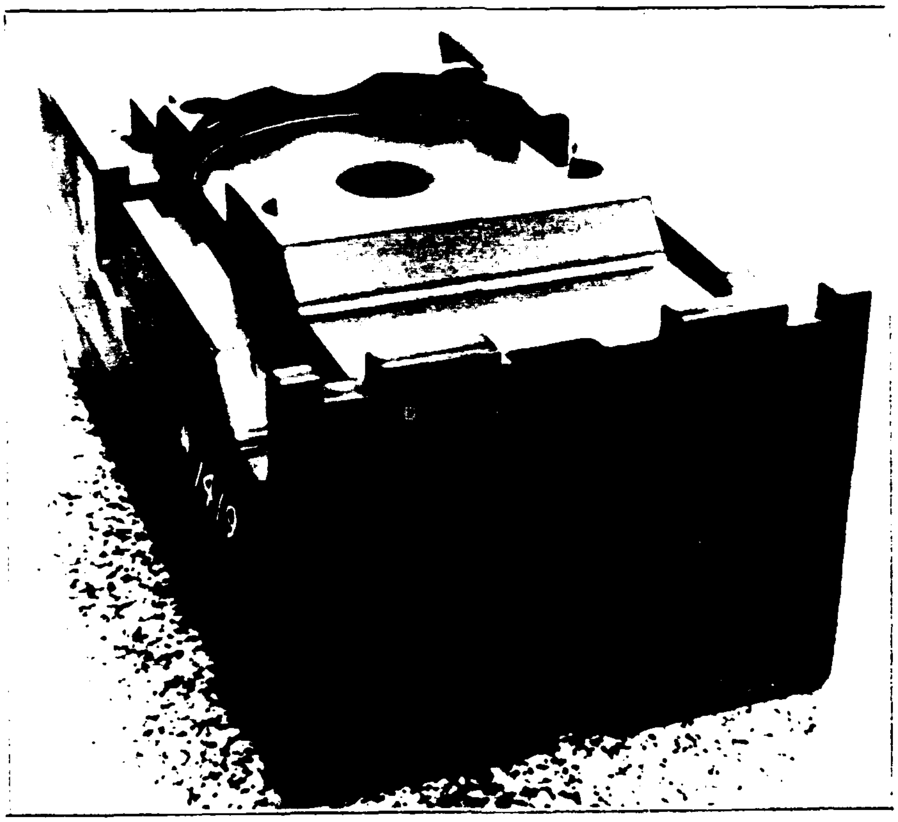
(a)

(b)

Figure 7. Photographs showing weld repair breechblock specimens (a) prior to and (b) after finish machining.



(a)



(b)

Figure 8. Photographs showing weld repair breechblock specimens (a) prior to and (b) after finish machining.

APPENDIX A

SARWV WELD REPAIR PROCEDURE # 35 DATED 10 April 1985

Rev. A DATED 28 January 1991

BASE METAL
Steel Forging per MIL-S-46172 Grade B
120MM Breechblock Material (4335 mod)

SURFACE PREPARATION
Machined or Ground Surface

PRE-INSPECTION
NA (Tool Gouge)

CLEANING
Remove all surface contamination and acetone wash.

PROCESS
Tig (GTAW)

FLUX or INERT GAS
100% Argon

POWER SOURCE/TYPE
Hobart Cyber Tig (GTAW)

CLASSIFICATION & SIZE OF FILLER METAL
AWS A5.28 Class ER 120S-1
1/16" - 1/8" dia.

POSITION OF WELD
Flat

AUTOMATIC SPEED
N/A

BACKING
Base Metal

PREHEAT
550°F to 600°F

INTERPASS TEMPERATURE
500°F min. 800°F max. measured 1" from weld.

POST HEAT
550°F to 600°F

STRESS RELIEVE
N/A

COMPONENTS APPROVED FOR REPAIR BY THIS METHOD
120mm Breechblock. Dwg. 12529521
Process Engineering Branch, Waiver & Deviation, and Product Engineering Branch to determine areas that can be weld repaired with this procedure.

REMARKS
Use stringer beads.
Do not weave.
Weld bead not to exceed 3/16 in. width.

WELDING AFTER NITRIDING NOT PERMITTED.

POST INSPECTION/TEST
Magnetic Particle (Wet) per Dwg. 7309992 - No Cracks Allowed.

HEAT TREATMENT
After machining or grinding send to Heat Trat for ion nitriding to 15N - 85 min., 0.20 + 0.10 deep.

SIGNATURE APPROVALS	SMCAR-CCB-SP	WAIVER & DEVIATION	SMCAR-CCB-DP
DATE	24 Jan 91	22 Aug 91	22 [illegible]

PHYSICAL PROPERTIES		DO NOT / DO	APPLY PART NO. / AS SPECIFIED
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REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL
NEW	SEE E.O.12744		
A	SEE E.O.12974	9-21-63	
B	SEE E.O. 14752	5-10-66	

(B)

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4. MAGNETIZATION REQUIREMENTS

A. THE INSPECTION MEDIA UTILIZED SHALL BE APPLIED BY THE CONTINUOUS METHOD ONLY.

B. DIRECT CURRENT SHALL BE USED UNLESS OTHERWISE SPECIFIED.

C. THE BREECHBLOCK SHALL BE MAGNETIZED BY BOTH THE LONGITUDINAL AND CIRCULAR METHODS.

5. MAGNETIZATION PROCEDURES

A. MAGNETIZATION - FOR THE DETECTION OF INDICATIONS IN THE PLANE PARALLEL TO THE GUN AXIS, A COIL WRAPPED AROUND THE CENTER OF THE BLOCK AND A CURRENT OF 150 - 200 AMPERE-TURNS PER INCH OF WIDTH OR 800 AMPERE-TURNS; WHICHEVER CURRENT IS GREATER, SHALL BE USED.

B. MAGNETIZATION - FOR THE DETECTION OF INDICATIONS IN THE PLANE PERPENDICULAR TO THE GUN AXIS, A COIL WRAPPED ABOUT THE LENGTH OF THE BLOCK AND A CURRENT OF 150 - 200 AMPERE-TURNS PER INCH OF LENGTH OR 800 AMPERE-TURNS; WHICHEVER CURRENT IS GREATER, SHALL BE USED.

6. ALL MAGNETIC PARTICLE INSPECTION PERSONNEL SHALL BE CERTIFIED IN ACCORDANCE WITH SPECIFICATION MIL-STD-410.

(A)

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MATERIAL	SUBMITTED [signature]	SCALE	A 7309992
HEAT TREATMENT	APPROVED [signature] R. W. Arokian	UNIT WT	CODE 19206 — SHEET 2 OF 2
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